(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
11 November 2004 (11.11.2004)

PCT

(10) International Publication Number
WO 2004/097724 A1

(51) International Patent Classification[7]: G06K 13/08, 13/067

(21) International Application Number: PCT/IB2004/050521

(22) International Filing Date: 27 April 2004 (27.04.2004)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
03101184.4 29 April 2003 (29.04.2003) EP

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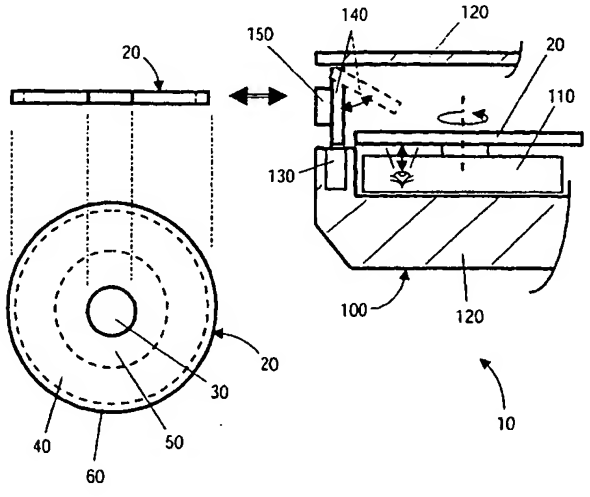
(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*

[Continued on next page]

(54) Title: INSERTION PROTECTION SYSTEM



(57) Abstract: There is provided an insertion protection system (10) for controlling access of a recording medium (20) into an apparatus (100) operable to read data from and/or to write data to the medium (20). The medium (20) includes one or more identifying features (315; 405). Moreover, the apparatus (100) includes an interrogation arrangement (300, 310, 320, 350, 360; 400, 420, 425, 430, 440) for interrogating the identifying features (315; 405) for measuring one or more response characteristics thereof to generate one or more corresponding characteristic indicative signals. The apparatus (100) also includes an access controlling arrangement (230, 250, 370; 230, 250, 370) for receiving the one or more indicative signals for executing at least one of: (I) allowing access or denying access of the medium (20) to the apparatus (100) depending upon the nature of the one or more indicative signals; and (ii) generating at least one of an audio warning and a visual warning depending upon the nature of said one or more indicative signals. The medium (20) is susceptible to being at least one of a Smart card.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Insertion protection system

The present invention relates to insertion protection systems; in particular, but not exclusively, the invention relates to insertion protection systems suitable for use with recording media such as minidiscs, Smartcards, banking cards, DVDs and CDs and apparatus operable to interrogate such recording media to extract data and information therefrom and/or to write data and information thereto. Moreover, the invention also relates to methods of providing insertion protection for recording media and apparatus operable to interrogate and/or to write to such media.

Combinations of recording media and non-contact identification devices, for example in a manner of spatial co-location, are known. Such combinations are described in a European patent application no. EP-A-0, 809, 245, in a published international PCT patent application no. PCT/US99/23630 (WO00/23994), in a United States patent no. US 6, 496, 883, and also in a United States patent no. US 5, 862, 117. In the applications EP-A-0, 809, 245, PCT/US99/23630, and in the patent US 5, 862, 117, transponder devices are included towards central portions of DVD, CD and/or Software disks.

For example, in the patent US 5, 862, 117, there is described a compact disc comprising a data storage medium for optical reading, the medium situated in an annular region of the disc. The medium defines a central region wherein is arranged an electronic module. The module comprises an electronic unit, in particular an integrated circuit, and an antenna formed by a winding fabricated from an electrically conductive material. The electronic module is operable to provide contactless electromagnetic coupling with an electromagnetic wave transmitter-receiver capable of communicating with the electronic unit. Moreover, the electronic unit comprises an identification code and/or a decoding key for the data recorded in the storage medium. A purpose for including the electronic module is to provide protection against unauthorised copying of data stored in the storage medium, for example as occurs in copyright infringement and hacking of recordings.

The inventors have appreciated that apparatus for interrogating recording media, for example domestic consumer CD players and DVD players, are frequently

susceptible to abuse, for example such apparatus are susceptible to damage as a consequence of incompatible media being offered thereto. Moreover, the inventors have also appreciated that such apparatus can also be damaged by other types of foreign object being inserted thereinto, for example children's Lego bricks being inserted into domestic DVD players.

Thus, the inventors have appreciated that it is desirable to provide insertion protection for apparatus for interrogating recording media without significantly increasing one or more of the cost and complexity of such apparatus and media. The aforesaid known non-contact devices are potentially relatively expensive and also require additional fabrication steps for their inclusion into recording media and therefore represent an unsatisfactory solution.

It is a first object of the invention to provide an insertion protection system which is capable of preventing unsuitable items from being inserted into apparatus suitable for interrogating data bearing media.

The list of unsuitable items comprising, but limited to, counterfeit data bearing media, toys and objects that might harm the apparatus when inserted.

According to a first aspect of the present invention, there is provided an insertion protection system for use in controlling access of a recording medium into an apparatus operable to read data from and/or to write data to the medium, the medium including one or more identifying features, the apparatus including interrogating means for interrogating the identifying features for measuring one or more response characteristics thereof to generate one or more corresponding characteristic indicative signals, and access controlling means for receiving said one or more indicative signals for executing at least one of:

(a) generating at least one of an audio warning and a visual warning depending upon the nature of said one or more indicative signals; and

(b) allowing access or denying access of said medium to said apparatus depending upon the nature of said one or more indicative signals.

The system is of advantage in that it is capable of executing at least one of:

(i) preventing unsuitable items from being inserted into apparatus suitable for interrogating data bearing media and/or preventing counterfeit data bearing media from being interrogated to read data therefrom and/or write data thereto; and

(ii) providing a warning of the potential insertion of unsuitable objects into apparatus suitable for interrogating data bearing media and/or preventing counterfeit data bearing media from being interrogated to read data therefrom and/or write data thereto.

Preferably, the one or more identifying features are incorporated integrally within the medium. Such an arrangement if capable of reducing manufacturing cost and/or rendering the identifying features are difficult to counterfeit. More preferably, the medium is fabricated from a plastics material and the identifying features are included in the plastics material when molded to form the medium.

In order to simplify manufacture and not substantially increase manufacturing cost of the medium, the one or more identifying features are fabricated from one or more extensions of a structure included in the medium adapted for data storage purposes. Dual use of the structure for both data storage and access control is capable of providing the medium with synergistic benefits.

Preferably, the identifying features include one or more of optically interrogatable features and inductively interrogatable features. Such features are of advantage in that they are susceptible to being interrogated using relatively low cost transducers.

Preferably, the optically interrogatable features include one or more fluorescent materials.

More preferably, the one or more fluorescent materials are operable to fluoresce at a plurality of wavelength ranges when exposed to optical excitation radiation from the interrogating means, and the interrogating means is operable to determine a ratio of fluorescent optical intensities at a plurality of the wavelength ranges to generate the one or more indicative signals. Such a ratio form of detection renders the system less influenced by absolute levels of radiation intensity from the interrogating means and surface contamination on the medium and/or interrogating means.

Preferably the one or more fluorescent materials are operable to fluoresce in at least one wavelength range when exposed to optical excitation radiation from the interrogating means, and the interrogating means is operable to determine fluorescent optical intensity at the at least one wavelength range to generate the one or more indicative signals.

More preferably, the interrogating means is operable to excite the one or more fluorescent materials using strobed optical radiation to generate strobed fluorescent radiation from the one or more fluorescent materials in at least one wavelength range, and the interrogating means is operable to demodulate the strobed fluorescent radiation with respect to the strobe in order to generate the one or more indicative signals. Such an arrangement is

capable of rendering the system less influenced by quasi-static ambient optical radiation whose contribution is susceptible to being removed during demodulation relative to the strobe.

More preferably, the one or more fluorescent materials include one or more of fluorescein isothiocyanate (FITC), R-phycoerythrin (RPE), B-phycoerythrin (BPE), rhodamine, rhodamine-B, allophycocyanin, Alexa Fluor 350, Alexa Fluor 430, Alexa Fluor 488, Alexa Fluor 532, Alexa Fluor 594, Alexa Fluor 633, Alexa Fluor 680, BODIPY 493/503, BODIPY 665/676, Cy5, Texas Red and Termethyl rhodamine isothiocyanate (TRITC).

Preferably, the one or more fluorescent materials are susceptible to fluorescent excitation in response to excitation radiation having a wavelength in a range of 346 nm to 684 nm.

Preferably, the inductively interrogatable features include one or more conductive loops comprising one or more turns of conductor embedded within the medium, the one or more conductive loops being susceptible to inductively-coupled interrogation for modifying one or more resonance characteristics of the interrogating means for generating the one or more indicative signals.

Preferably, the recording medium is at least one of a Smartcard, an identification card, a minidisc, an audio CD, a DVD and a Software CD.

According to a second aspect of the present invention, there is provided a method of providing an insertion protection system for use in controlling access of a recording medium into an apparatus operable to read data from and/or to write data to the medium, the method including the steps of:

(a) arranging for the medium to include one or more identifying features;

(b) arranging for the apparatus to include interrogating means and access controlling means;

(c) interrogating the identifying features using the interrogating means for measuring one or more response characteristics thereof to generate one or more corresponding characteristic indicative signals; and

(d) receiving the one or more indicative signals at the controlling means for executing at least one of:

(i) allowing access or denying access of the medium to said apparatus depending upon the nature of said one or more indicative signals; and

(ii) generating at least one of an audio warning and a visual warning depending upon the nature of said one or more indicative signals.

According to a third aspect of the present invention, there is provided a recording medium including substantially at a peripheral edge thereof one or more identifying features susceptible to interrogation for preferentially executing at least one of:

(i) allowing access or denying access of the medium into an apparatus operable to read data from and/or write data to the medium depending upon the nature of the one or more identifying features; and

(ii) generating at least one of an audio warning and a visual warning depending on the nature of the one or more identifying features,

the identifying features including one or more of optically interrogatable features and inductively interrogatable features.

Preferably, the optically interrogatable features include one or more fluorescent materials. Moreover, preferably, the recording medium is at least one of a Smart card, a banking card, an identification card, a minidisk, an audio CD, a DVD and a Software CD.

According to a fourth aspect of the present invention, there is provided an apparatus operable to read data from and/or to write data to a recording medium, the apparatus including an insertion protection system for use in controlling access of the medium into the apparatus, the medium including one or more identifying features, the apparatus including interrogating means for interrogating the identifying features for measuring one or more response characteristics thereof to generate one or more corresponding characteristic indicative signals, and access controlling means for receiving the one or more indicative signals for executing at least one of:

(i) allowing access or denying access of the medium to the apparatus depending upon the nature of the one or more indicative signals; and

(ii) generating at least one of an audio warning and a visual warning depending upon the nature of said one or more indicative signals.

It will be appreciated that features of the invention are susceptible to being combined in any combination without departing from the scope of the invention.

Embodiments of the invention will now be described, by way of example only, with reference to the following drawings wherein:

Fig. 1 is a schematic illustration of an insertion protection system according to the invention;

Fig. 2 is an illustration of an access actuator mechanism and sensor assembly of the system of Figure 1;

Fig. 3 is an illustration of a first implementation of the system of Figure 1 using optical access control; and

Fig. 4 is an illustration of a second implementation of the system of Figure 1 using radio frequency (RF) coupled access control.

In order to further elucidate the present invention, embodiments of the invention will now be described.

Referring to Figure 1, there is shown an insertion protection system indicated generally by 10. The system 10 is operable to control access of a recording medium indicated by 20 into an apparatus indicated by 100 and/or to generate one or more of an audio and a visual warning depending upon the nature of the medium 20. The apparatus 100 is capable of reading data recorded onto the medium 20. For example, the medium 20 is preferably one of a compact disc (CD), a Digital Versatile Disc (DVD) and a software disc (Software CD). In other alternative uses, the medium 20 is at least one of a Smartcard, a banking card and an identification card.

The medium 20 is preferably a substantially circular planar component susceptible to optical interrogation to read data therefrom. The medium 20 includes a central hole 30, an inner annular margin 50 substantially devoid of data, an annular data region 40 bearing optically readable data and an outer margin 60 again substantially devoid of data with exception of features described later. Moreover, the medium 20 comprises three planar layers coupled together into a stacked arrangement, the planar layers in order being a first outer layer, an intermediate optical data layer, and a second outer layer. The outer layers are conveniently fabricated from a substantially optically transparent plastics material such as transparent polycarbonate material as employed in contemporary commercial CD's. The intermediate optical layer is a metallic-type layer for bearing optically readable data, the data being recorded on the intermediate layer at one or more of initial fabrication and subsequent to manufacture by causing an optical phase change in the intermediate layer, for example in a manner of rewritable contemporary CD's.

The inventors have appreciated that the outer margin 60 is capable of bearing features susceptible to recognition by the apparatus 100, such features not interfering with normal data readout from and/or writing to the annular data region 40. The features are beneficially one or more of optically and radio frequency (RF) responsive as described in greater detail later.

The apparatus 100 includes an exterior housing 120 for providing support to an optical interrogation unit 110 therein as illustrated. The apparatus 100 further includes a pivotally-mounted access door 140 arranged to guard an access port provided in a front side of the housing 120, the front side being normally user-accessible. Moreover, the door 140 is laterally elongate and mechanically pivotally mounted near its elongate upper edge to an upper edge of the access port. Near a lower edge of the access port and incorporated into the housing 120, there is included an actuator mechanism 130 operable to switch between locked and unlocked states. In the locked state, the mechanism 130 is operable to prevent the door 140 from inwardly pivoting thereby hindering access via the access port to the optical unit 110. Conversely, in the unlocked state, the mechanism 130 retracts a pin from the door 140 enabling the door 140 to pivot to allow access to the optical unit 110, for example for inserting the medium 20 onto the optical unit 110 for reading data therefrom, for example for playing a DVD where the medium 20 is a DVD optical disc and the optical unit 110 is an optical laser DVD reader and/or writer.

On an outwardly-facing surface of the access door 140, there is mounted an access sensor 150. The sensor 150 includes transducers capable of interrogating the outer margin 60 of the medium 20 when offered to the sensor 150.

Operation of the system 10 will now be described with reference to Figure 1.

The apparatus 100 is arranged so that when stored or when initially activated by applying power thereto, the actuator mechanism 130 is resiliently biased so as to prevent the door 140 pivoting and thereby prevent access to the optical unit 110. When the apparatus 100 is energized, a user holds the medium 20, for example between his/her fingers, and offers the outer margin 60 of the medium 20 to the sensor 150 which recognizes the medium 20 as being bona fide and susceptible to interrogation by the optical unit 110. The sensor 150 sends a signal to the mechanism 150 to switch from its locked state to its unlocked state thereby enabling the door 140 to pivot inwardly, thereby allowing the user to place the medium 20 onto a rotatable platter of the optical unit 110. The apparatus 100 then actuates the door 140 to its closed position where the mechanism 130 returns to its locked state to hinder pivotal movement of the door 140. The user then operates one or more switch controls (not shown),

for example a PLAY button, to cause the optical unit 110 to read data from the annular data region 40 and thereby generate one or more of audio and visual signals for presentation to the user.

The sensor 150 thereby enables the apparatus 100 to selectively allow bona fide media to be inserted into the apparatus 100.

When the user removes the medium 20 from the apparatus 100 and subsequently attempts to offer another type of object to the sensor 150, for example an edge of a Lego brick, an edge of a business card, a counterfeit CD and/or DVD, the sensor 150 is unable to detect one or more characteristic responses therefrom, an absence of the one or more characteristic responses indicative to the apparatus 100 that access should be denied to the other type of object.

The protection system 10 is capable of preventing the apparatus 100 being used to replay counterfeit material and/or preventing unsuitable objects being introduced into the apparatus 100 which could damage the apparatus 100.

If required, as an alternative or addition to the mechanism 130, the apparatus 100 beneficially includes one or more of an audio warning device and a visual warning device so that the user's attention is drawn to the nature of the medium 20 by one or more of a corresponding audio warning and a corresponding visual warning. If required, the mechanism 130 can be arranged to be manually operable to the user in response to the audio warning and/or visual warning generated when the medium 20 is offered to the sensor 150. For example, offering the medium 20 to the sensor 150 causes the door 140 to be switched automatically to an unlocked state, whereas offering a foreign object to the sensor 150 requires the user to depress deliberately one or more access switches, for example a plurality of switch buttons on the housing 120 in combination, to switch the mechanism 130 to an unlocked state for allowing the foreign object access through the door 140 to the optical unit 110; for example, small children would not potentially be aware of the need to depress a combination of buttons and hence would be unable to insert foreign items, for example Lego bricks, into the apparatus 100. Such a manual arrangement in conjunction with at least one of an audio warning and a visual warning is of benefit in that the apparatus 100 is susceptible thereby of receiving earlier types of potentially compatible recording media devoid of identification features; thus, there is potential for achieving backward compatibility with earlier types of recording media by way of such manual intervention.

The system 10 will now be described in further detail with reference to Figure 2. The mechanism 130 comprises a slidable locking pin 230 illustrated in unlocked 230a and

locked 230b states respectively. When in the pin 230 is in its locked state 230b, it prevents pivotal movement of the door 140 about its pivotal axis denoted by 200. The mechanism 130 includes an actuator 250, for example an electromagnetic solenoid or micromotor, for moving the pin 230 between its associated states, the actuator 250 being resiliently biased to move the pin 230 to its locked state 230b when the apparatus 100 is not energized, for example switched off and/or during shipment.

In a first example of the system 10, the sensor 150 comprises an optical emitter 210 and a corresponding optical receiver 220. The emitter 210 and the receiver 220 are spatially arranged to define an interrogation region therebetween, for example in the form of a slot, as illustrated suitable for receiving the outer margin 60 of the medium 20. Thus, in operation, the emitter 210 emits interrogating optical radiation which propagates to the outer margin 60 and reacts therewith to generate corresponding response optical radiation which is received at the receiver 220 to generate a corresponding electrical output signal thereat. Beneficially, the interrogating radiation is temporally strobed so that the response radiation is also strobed, thereby enabling the electrical output signal from the receiver 220 to be demodulated with respect to the strobe and hence remove influence of any quasi-static ambient optical radiation present, for example room lighting and/or sunlight. In Figure 2, the emitter 210 and the receiver 220 are spatially arranged to interrogate the outer margin 60 in transmission mode. Alternatively, the emitter 210 and the receiver 220 can be arranged to interrogate the outer margin 60 in an optical reflection mode where the emitter 210 and receiver 220 are arranged mutually adjacently and the receiver 220 is operable to receive radiation emitted back from the outer margin 60. When the reflected radiation bears a characteristic relationship to the interrogating radiation, the sensor 150 is capable of identifying that a bona fide object has been presented to the apparatus 100 so that the mechanism 130 can be energized to allow the door 140 to be pivotally opened and thereby enable the user to place the medium 20 onto the optical unit 110.

If required, the sensor 150 can be mounted directly on an accessible exterior surface of the housing 120, for example on an exterior surface of the housing 120 immediately above and/or below the door 140. In operation, the user offers the medium 20 to the sensor 150 mounted on the housing 120 to "unlock" the door 140 and then proceeds to insert the medium 20 through the access port to locate it onto the platter of the optical unit 110.

Operation of the sensor 150 as depicted in Figure 2 will now be elucidated in greater detail with reference to Figure 3.

The sensor 150 comprises an oscillator (SYNC) 310 for generating a synchronisation output signal A1. Beneficially, the oscillator 310 is part of a digital circuit already forming an integral part of the apparatus 100, for example a digital output from a microcontroller of the optical unit 110. The sensor 150 comprises an optical radiation source 300 included within the aforementioned emitter 210 connected to the output signal A1 of the oscillator 310 for generating strobed interrogating radiation substantially at a wavelength of λ_0. Preferably, the source 300 is an ultraviolet light emitting diode (LED), a blue LED or a low-power blue/ultraviolet solid-state integrated-circuit laser operable to output relatively short wavelength optical radiation having a wavelength in a range of 300 nm to 400 nm.

The sensor 150 further comprises a photodetector (DET) 350 preceded by an optical filter (FLT) 320 including an optical main-field filter 330 and optionally an optical sub-field filter 340. The photodetector 350 and its filter 320 are included within the aforementioned receiver 220. The photodetector 350 comprises an electrical output B connected to a signal input of a synchronous demodulator 360 strobed by an output signal A2 from the oscillator 310 which is synchronized with the output signal A1 to the source 300. A synchronously demodulated output C from the demodulator 360 is coupled to a control unit (CTRL) 370. The control unit 370 includes an output (EXT) for providing signals to other parts of the apparatus 100, for example to the optical unit 110 indicative of whether or not a bona fide data medium is expected to be inserted into the apparatus 100, and also a lock output D coupled to the actuator 250 for actuating the pin 230 in directions as indicated by an arrow 240.

Operation of the sensor 150 is as follows. The oscillator 310 outputs the strobe signal A1 to the source 300 and to the demodulator 360. The source 300 emits strobed interrogating radiation substantially at the wavelength of λ_0. The interrogating radiation propagates to the outer margin 60 of the medium 20 inserted into the slot of the sensor 150 and is received at fluorescent particles, for example a particle 315, incorporated into the first and second layers of the medium 20. At the outer margin 60, the intermediate layer of the medium 20 is substantially absent so that the particles 315 are capable of absorbing the strobed interrogating radiation of wavelength λ_0 and then by a fluorescence process re-emitting the radiation at one or more wavelengths λ_1, λ_2 which are longer than the wavelength λ_0. The fluorescence process occurring in the particles 315 is of shorter temporal duration in comparison to a strobe frequency employed, for example the strobe frequency is preferably in a range of 1 kHz to 100 kHz, and more preferably substantially 10 kHz. If required, the particles 315 can comprise one or more mutually different types of

fluorophores, each fluorophore operable to re-emit radiation at one or more wavelengths characteristically associated with the type of fluorophore. Most preferably, the one or more fluorophores comprise at least one of fluorescent dyes in a proprietary Alexa dye series; this series includes several bright fluorophores exhibiting an optimal excitation radiation wavelength range of 346 nm to 684 nm. The one or more fluorophores beneficially include at least one of fluorescein isothiocyanate (FITC), R-phycoerythrin (RPE), B-phycoerythrin (BPE), rhodamine, rhodamine-B, allophycocyanin, Alexa Fluor 350, Alexa Fluor 430, Alexa Fluor 488, Alexa Fluor 532, Alexa Fluor 594, Alexa Fluor 633, Alexa Fluor 680, BODIPY 493/503, BODIPY 665/676, Cy5, Texas Red and Termethyl rhodamine isothiocyanate (TRITC). The particles 315, namely the one or more fluorophores, are preferably added to plastics material used to fabricate the medium 20 at manufacture thereof; most preferably, the fluorophores do not substantially interfere with data readout from the data region 40 when interrogated by the optical unit 110.

Thus, radiation received at the filter 320 comprises first, second and third wavelength λ_0, λ_1, λ_2 components respectively. The filter 320 is operable to transmit substantially only the second and third wavelength components λ_1, λ_2 and substantially reflect and/or absorb the first radiation component λ_0. When the optical sub-field filter 340 is also present, the sub-field filter 340 only transmits the third radiation component λ_2 therethrough, thereby providing differential radiation components to different spatial regions of the detector 350.

In a situation where the medium 20 with its fluorescent particles 315 are not presented to the sensor 150, the second and third radiation components λ_1, λ_2 are substantially absent in radiation received at the filter 320 and substantially very little strobed radiation is received at the detector 350.

When the medium 20 is present, the detected signal B from the detector 350 corresponding to the strobed radiation components λ_1, λ_2 received thereat passes to the demodulator 360 which demodulates this signal B to generate the corresponding demodulated signal C which passes to the control unit 370. If the demodulated signal C is within a predefined magnitude range, the control unit 370 recognizes thereby that the medium 20 presented to the sensor 150 is bona fide and outputs the signal D to the actuator 250 to set the pin 230 to its unlocked state 230a, thereby enabling the door 140 to pivot to allow the user access to insert the medium 20 onto the optical unit 110.

Preferably, the medium 20 includes one or more fluorescent materials which re-emit the radiation λ_0 from the source at a plurality of different wavelengths ranges, for example around wavelengths λ_1, λ_2. Moreover, the filter 320 beneficially includes the sub-filter 340. Furthermore, the detector 350 is beneficially operable to generate first and second detected signal S_1, S_2 respectively; namely, the signal B comprises the signals S_1, S_2. The first signal S_1 corresponds to radiation transmitted through solely the main-field filter 330 at wavelengths λ_1, λ_2 received at a first spatial region of the detector 350, and the second signal S_2 corresponds to radiation transmitted through both the main-field filter 330 and the sub-filter 340 at the wavelength λ_2 received at a second spatial region of the detector 350, the first and second spatial regions being preferably spatially mutually different. The demodulator 360 is correspondingly operable to demodulate the signals S_1, S_2 with respect to the strobe signal A2 from the oscillator 310 to generate corresponding demodulated signals Q_1, Q_2 respectively.

For one or more specific types of fluorophores present in the outer margin 60 of the medium 20, the signals Q_1, Q_2 arise in a characteristic ratio indicative that the medium 20 is bona fide. Thus, the control unit 370 is operable to receive the two signals Q_1, Q_2 and calculate a ratio therebetween; if the ratio therebetween is within a pre-defined range, the control unit 370 recognizes the medium 20 to be bona fide and in response outputs the control signal D to the actuator 250 to move the pin 230 to its unlocked state 230a. Conversely, if a Lego brick, credit card or similar type of foreign item is offered to the sensor 150, there will not be generated any significant fluorescent signal, let alone a signal with a characteristic ratio of fluorescent radiation components, at the detector 350 with a result that the control unit 370 outputs the signal D to the actuator unit 250 to maintain the pin 230 in its locked state 230b to prevent the door 140 being opened. Such ratiometric control is of advantage in that it renders the insertion protection system 10 relatively insensitive to absolute magnitude of interrogating radiation output from the source 300, namely rendering the system 10 less liable to malfunction due to one or more of ageing of the source 300, deposition of optical contamination such as dust on the source 300, ageing of the filter 320 and/or detector 250, and deposition of optical contamination such as dust on the detector 350.

It will be appreciated in Figure 3 that the source 300, the filter 320 and the detector 350 are susceptible to being arranged to interrogate the outer margin 60 of the medium 20 in reflection mode at one face thereof in contradistinction to a transmission arrangement as illustrated in Figure 3. Such a reflection arrangement reduces the magnitude

of the radiation component λ_0 received at the filter 320 and is therefore preferable in some circumstances.

It will be appreciated that the protection system 10 can be implemented either additionally or alternatively using electro-magnetically coupled components. Such an arrangement is illustrated in Figure 4. The medium 20 includes in its outer margin 60 one or more loop conductors, for example a loop conductor 405 comprising one or more turns. Preferably, the loop conductors 405 are repeated at substantially regular radial intervals around the outer margin 60. The one or more conductors 405 are beneficially fabricated from a material used for the intermediate layer of the medium 20 employed in the data region 40 for recording data thereon, the intermediate layer being preferably a vacuum evaporated, vacuum sputter coated or chemically deposited metallic-type conductive layer. Such an arrangement ensures that the intermediate layer is also employed synergistically for providing insertion protection as well as data storage.

The system 10 as implemented in Figure 4 comprises a radio frequency signal source 420 whose outputs E1, E2 are arranged to drive a series connection of a load impedance Z_L 425 and a loop antenna 400 as illustrated; the antenna 400 is preferably formed by a metal film track on a printed circuit board (PCB) or on a flexible connector strip such a metallic foil Kapton connector strip. Moreover, the loop antenna 400 includes one or more turns of conductor. Connections across the antenna 400 F1, F2 are coupled to differential inputs of an amplifier 430 whose output G is coupled to a radio frequency demodulator 440, for example a heterodyne demodulator utilizing a reference signal from the oscillator 420 or alternatively a simple diode-based detector. A demodulated output H from the demodulator 440 is coupled to an input of a control unit 450 operable to compare the demodulated output H with one or more threshold values. An output J of the control unit 450 is coupled to the actuator 250 for actuating the pin 230 into its unlocked state 230a when the demodulated signal H assumes a particular range of values relative to the one or more predefined reference values. Preferably, the control unit 450 is capable of sweeping the frequency of the radio frequency outputs E1, E2 from the oscillator 420 over a range including resonance of the load Z_L in combination with the antenna 400.

Operation of the insertion protection system illustrated in Figure 4 will now be described.

The oscillator 420 generates its output signals E1, E2 to drive the load 425 and the antenna 400 through electrical series resonance; preferably, the load 425 is capacitive and the antenna 400 exhibits inductive impedance at the operating frequency of the oscillator 420.

The control unit 450 causes the oscillator 420 to sweep through an electrical resonance of the antenna 400 in combination with its load 425. When the loop conductor 405 is brought into close mutual proximity to the antenna 400 to inductively mutually couple therewith, the electrical resonance occurs at a frequency of f_1. In contradistinction, the electrical resonance occurs at a frequency of f_2 when the loop conductor 405 is spatially remote from the antenna 400. As a consequence of sweeping through resonance, a potential developed across the antenna 400 reaches a maximum and/or minimum at resonance, depending upon output drive characteristics of the source 420. By way of the demodulator 440, the control unit 450 is capable of determining a frequency at which the resonance occurs and thereby determining whether it occurs at substantially the frequency f_1 or f_2. The control unit 450 is thereby operable to determine whether or not the loop conductor 405 is in close spatial proximity to the antenna 400 and therefore whether or not the medium 20 is bona fide. Preferably, in use, the user sweeps the outer margin 60 of the medium 20 relative to the sensor 150 in the manner akin to a swipe card whilst the control unit 450 monitors the resonance frequency repetitively during such a swiping movement.

It will be appreciated that the insertion protection system 10 is susceptible to being implemented in alternative ways to those described in the foregoing. For example, the outer margin 60 beneficially is provided with radial optical bar codes or similar types of features and the sensor 150 is implemented as an imaging device, for example as a charge coupled pixel-imaging device (CCD). When the outer margin 60 is inserted into the sensor 150, the sensor 150 is operable to image the outer margin 60 in one or more of optical transmission and optical reflection modes. The optical bar codes or similar types of features are susceptible to being formed in one of more of the intermediate layer of the medium 20 and printed onto an exterior surface of the outer margin 60. If required, fluorophore-based materials are beneficially employed for fabricating the features, such materials not interfering with normal optical interrogation of the medium 20 using the optical unit 110. Preferably, the fluorophore-based materials are molded into plastics materials of the medium 20.

It will be appreciated that embodiments of the invention described in the foregoing are susceptible to being modified without departing from the scope of the invention.

Although inclusion of the particles 315 comprising one or more types of fluorophore is described in the foregoing, it will be appreciated that the particles 315 are also susceptible to being alternatively or additionally included in one or more of the inner annular margin 50 and the annular data region 40. Moreover, the sensor 150 is also capable of being

adapted to interrogating regions other than the outer margin 60 as described in the foregoing. Preferably, the particles 315 are of a very fine form, for example less than 110 nm in size, so that they do not interfere with data readout from and/or data writing to the data region 40. Most preferably, the particles 315 are not included at the focal plane of intermediate optical data layer of the medium 20 so that the particles 315 are not detected by the optical unit 110 and/or do not interact with its normal operation.

Although the insertion protection mechanism as described in the foregoing is primarily intended to prevent unsuitable items being inserted into devices such as data reading devices, for example CD drives, it will be appreciated that the mechanism is useable as a counterfeit protection device for identifying counterfeit products from genuine products, and for preventing counterfeit products being used with devices equipped with the insertion protection mechanism. The mechanism is thereby capable of being a valuable tool against potential copyright infringement.

In the foregoing, it will be appreciated that terms "include" and "comprise" and variants thereof are to be interpreted to be non-exclusive, namely that other items, components and/or parts may also be present.

CLAIMS:

1. An insertion protection system (10) for use in controlling access of a recording medium (20) into an apparatus (100) operable to read data from and/or to write data to the medium (20), the medium (20) including one or more identifying features (315; 405), the apparatus (100) including interrogating means (300, 310, 320, 350, 360; 400, 420, 425, 430, 440) for interrogating said one or more identifying features (315; 405) for measuring one or more response characteristics thereof to generate one or more corresponding characteristic indicative signals, and access controlling means (230, 250, 370; 230, 250, 370) for receiving said one or more indicative signals for executing at least one of:

(a) generating at least one of an audio warning and a visual warning depending upon the nature of said one or more indicative signals;

(b) allowing access or denying access of said medium (20) to said apparatus (100) depending upon the nature of said one or more indicative signals.

2. A system (10) according to Claim 1, wherein the one or more identifying features (315; 405) are incorporated integrally within the medium (20).

3. A system (10) according to Claim 2, wherein the medium (20) is fabricated from a plastics material and the one or more identifying features (315) are included in the plastics material when molded to form the medium (20).

4. A system (10) according to Claim 1, wherein the one or more identifying features are fabricated from one or more extensions (405) of a structure (40) included in the medium (20) adapted for data storage purposes.

5. A system (10) according to Claim 1, wherein the one or more identifying features include one or more of optically interrogatable features (315) or inductively interrogatable features (405).

6. A system (10) according to Claim 5, wherein the optically interrogatable features include one or more fluorescent materials (315).

7. A system (10) according to Claim 6, wherein said one or more fluorescent materials (315) are operable to fluoresce at a plurality of wavelength ranges when exposed to optical excitation radiation from the interrogating means (300, 310, 320, 350, 360), and the interrogating means (300, 310, 320, 350, 360) is operable to determine a ratio of fluorescent optical intensities at a plurality of the wavelength ranges to generate said one or more indicative signals.

8. A system (10) according to Claim 6, wherein said one or more fluorescent materials (315) are operable to fluoresce in at least one wavelength range when exposed to optical excitation radiation from the interrogating means (300, 310, 320, 350, 360), and the interrogating means (300, 310, 320, 350, 360) is operable to determine fluorescent optical intensity at said at least one wavelength range to generate said one or more indicative signals.

9. A system (10) according to Claim 6, wherein the interrogating means (300, 310, 320, 350, 360) is operable to excite said one or more fluorescent materials using strobed optical radiation to generate strobed fluorescent radiation from said one or more fluorescent materials in at least one wavelength range, and the interrogating means is operable to demodulate the strobed fluorescent radiation with respect to the strobe in order to generate said one or more indicative signals.

10. A system (10) according to Claim 6, wherein said one or more fluorescent materials include one or more of fluorescein isothiocyanate (FITC), R-phycoerythrin (RPE), B-phycoerythrin (BPE), rhodamine, rhodamine-B, allophycocyanin, Alexa Fluor 350, Alexa Fluor 430, Alexa Fluor 488, Alexa Fluor 532, Alexa Fluor 594, Alexa Fluor 633, Alexa Fluor 680, BODIPY 493/503, BODIPY 665/676, Cy5, Texas Red and Termethyl rhodamine isothiocyanate (TRITC).

11. A system (10) according to Claim 10, wherein said one or more fluorescent materials are susceptible to fluorescent excitation in response to excitation radiation having a wavelength in a range of 346 nm to 684 nm.

12. A system (10) according to Claim 5, wherein said inductively interrogatable features include one or more conductive loops comprising one or more turns of conductor embedded within the medium (20), said one or more conductive loops being susceptible to inductively coupled interrogation for modifying one or more resonance characteristics of said interrogating means for generating said one or more indicative signals.

13. A system (10) according to Claim 1, wherein the recording medium is at least one of a Smartcard, a banking card, an identification card, a minidisc, an audio CD, a DVD and a Software CD.

14. A system according to claim 1, wherein the identifying features are located substantially at a peripheral edge region (60) of the medium.

15. A method of providing an insertion protection system (10) for use in controlling access of a recording medium (20) into an apparatus (100) operable to read data from and/or to write data to the medium (20), the method including the steps of:

(a) arranging for the medium (20) to include one or more identifying features (315; 405);

(b) arranging for the apparatus (100) to include interrogating means (300, 310, 320, 350, 360; 400, 420, 425, 430, 440) and access controlling means (230, 250, 370; 230, 250, 370);

(c) interrogating the identifying features (315; 405) using the interrogating means for measuring one or more response characteristics thereof to generate one or more corresponding characteristic indicative signals;

(d) receiving said one or more indicative signals at the controlling means (230, 250, 370; 230, 250, 370) for executing at least one of:

(i) allowing access or denying access of said medium (20) to said apparatus (100) depending upon the nature of said one or more indicative signals, and

(ii) generating at least one of an audio warning and a visual warning depending upon the nature of said one or more indicative signals.

16. A recording medium (20) including one or more identifying features susceptible to interrogation for preferentially executing at least one of:

(i) allowing access or denying access of said medium (20) into an apparatus (100) operable to read data from and/or write data to the medium (20) depending on the nature of the one or more identifying features; and

(ii) generating at least one of an audio warning and a visual warning depending upon the nature of said one or more identifying features,

the identifying features including one or more of optically interrogatable features (315) and inductively interrogatable features (405).

17. A medium according to claim 17, wherein the identifying features are located substantially at a peripheral edge (60) thereof.

18. A medium according to Claim 17, wherein the optically interrogatable features include one or more fluorescent materials.

19. A medium according to Claim 17, wherein the recording medium (20) is at least one of a minidisc, an identification card, a Smartcard, a banking card, an audio CD, a DVD and a Software CD.

20. An apparatus (100) operable to read data from and/or to write data to a recording medium (20), the apparatus (100) including an insertion protection system (10) for use in controlling access of the medium (20) into the apparatus (100), the medium (20) including one or more identifying features (315; 405), the apparatus (100) including interrogating means (300, 310, 320, 350, 360; 400, 420, 425, 430, 440) for interrogating the identifying features (315; 405) for measuring one or more response characteristics thereof to generate one or more corresponding characteristic indicative signals, and access controlling means (230, 250, 370; 230, 250, 370) for receiving said one or more indicative signals for executing at least one of:

(i) allowing access or denying access of said medium (20) to said apparatus (100) depending upon the nature of said one or more indicative signals; and

(ii) generating at least one of an audio warning and a visual warning depending upon the nature of said one or more indicative signals.

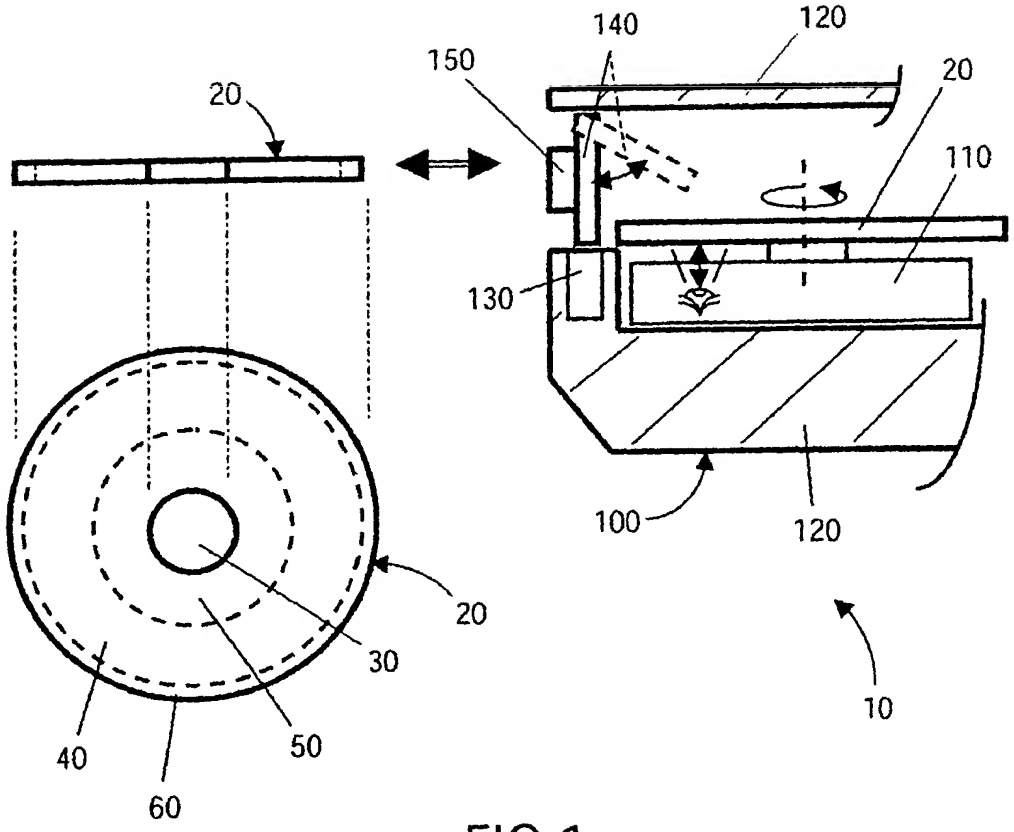


FIG.1

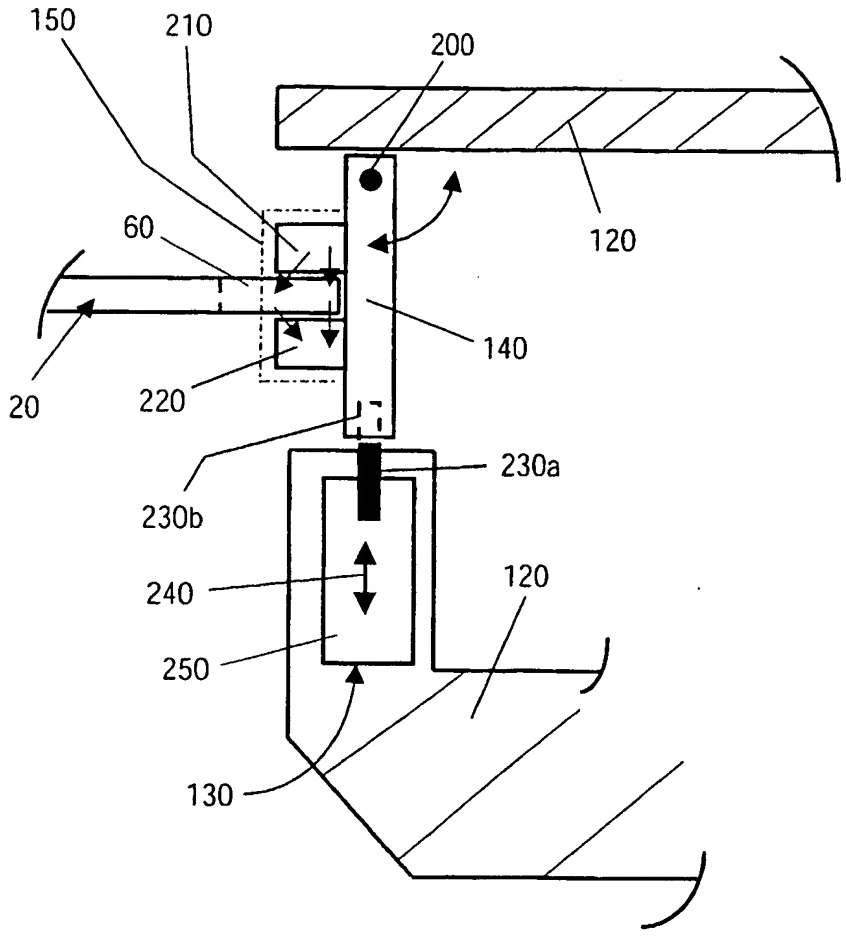
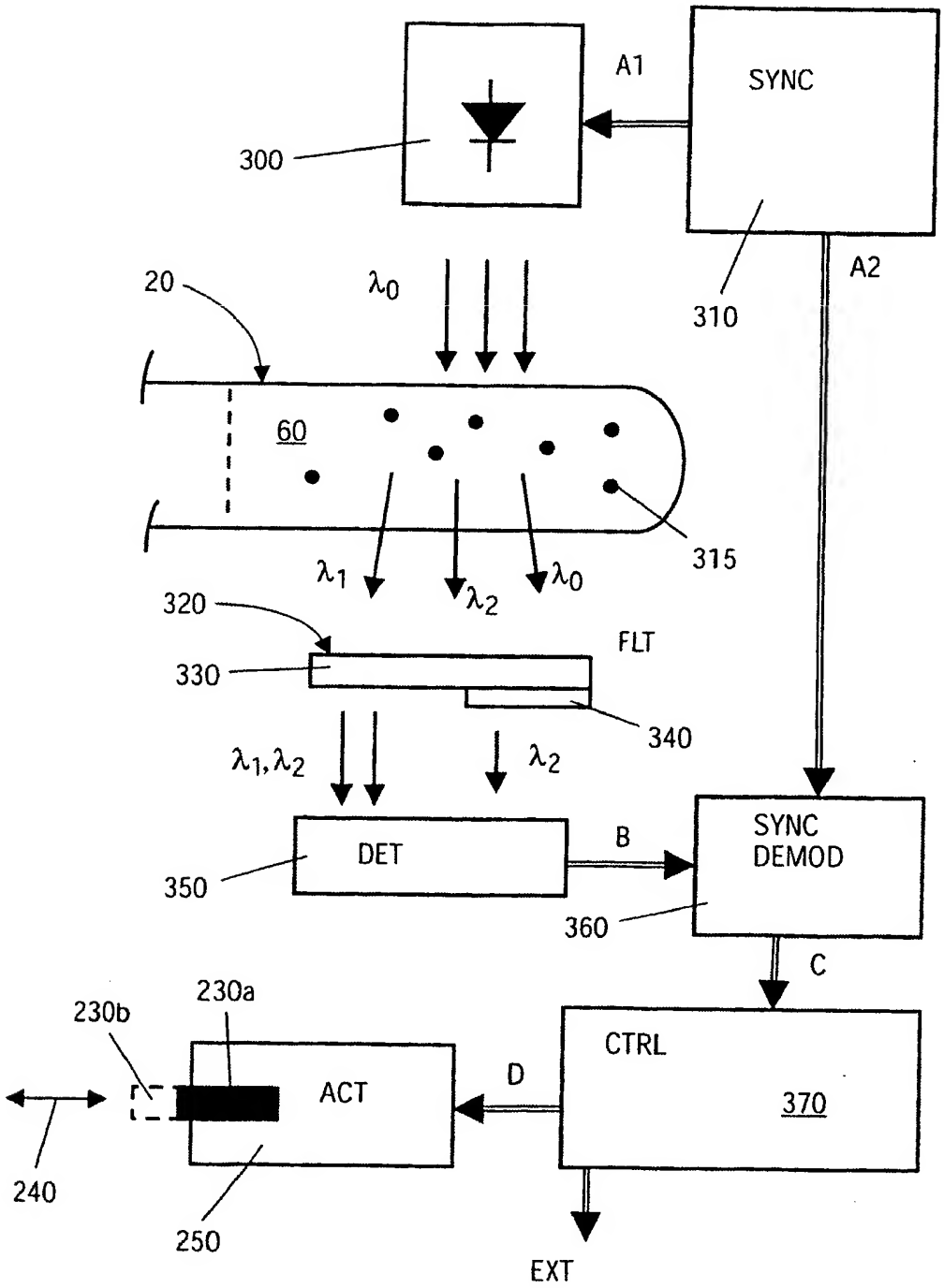


FIG.2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SYNC
300
310
A2
20
λ_0
60
315
λ_1
λ_2
λ_0
320
FLT
330
340
λ_1, λ_2
λ_2
DET
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DEMOD
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360
C
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230b
CTRL
D
ACT
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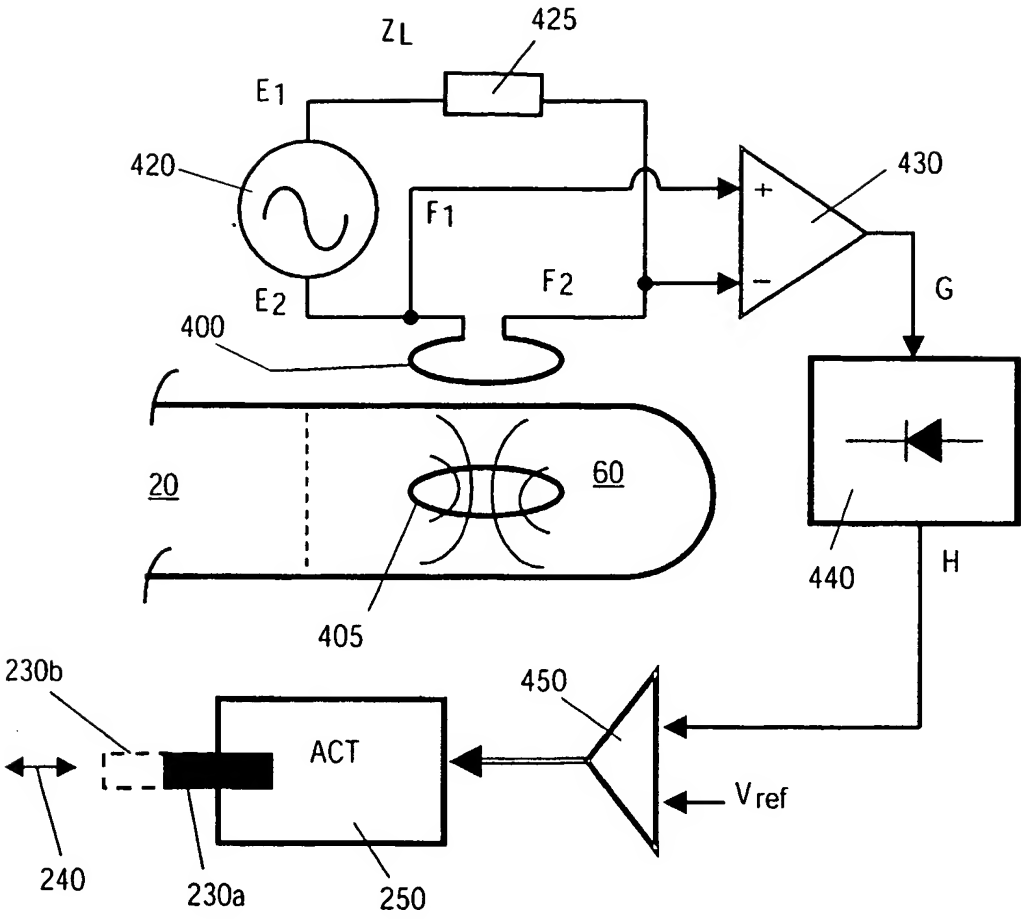
240
250
EXT

FIG.3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E1
420
F1
430
+
−
F2
G
E2
400
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60
405
440
H
230b
450
ACT
Vref
240
230a
250

FIG.4

INTERNATIONAL SEARCH REPORT

PCT/IB2004/050521

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G06K13/08 G06K13/067

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G06K G11B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, PAJ, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3 979 578 A (LEE ALBERT J ET AL) 7 September 1976 (1976-09-07) column 2, line 48 - column 11, line 66 figures 1-6	1-3,5, 13-17, 19,20
X	FR 2 704 958 A (FAVENNEC ALBERT) 10 November 1994 (1994-11-10) page 1, line 41 - page 2, line 65 figures 1-4	1-3,5, 13-17, 19,20
X	US 3 946 204 A (TANIGUCHI TADASU ET AL) 23 March 1976 (1976-03-23) column 3, line 3 - line 64 figures 1,2	1,2,4,5, 13-17, 19,20

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27 July 2004	06/08/2004

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	de Ronde, J.

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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